UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

JAPANESE BEETLE PROJECT

MOORESTOWN, N. J.

MISCIBLE CARBON DISULFIDE

The treatment of soil about the roots of nursery stock with dilute emulsions of carbon disulfide is one of the most effective methods for destroying the immature stages of the Japanese beetle (Popillia japonica Newm.) in the soil without causing serious damage to plants. A miscible carbon disulfide which has been perfected recently is the most satisfactory for the preparation of the dilute emulsions. It is no more injurious to plants, and furthermore, it has certain physical and chemical advantages.

PROPERTIES

Miscible carbon disulfide is a mobile, transparent liquid with a specific gravity of 1.1555 at 15° C. It does not form a heavy foam when shaken, and it can therefore be poured easily and measured accurately in small quantities. It mixes readily with water in all proportions, forming a white emulsion. Unlike emulsions containing soap and water, it does not stratify, but remains homogeneous. It does not disintegrate under normal conditions, and it can be held at a temperature of 32° F. (0° C.) for one week without breaking down. Carbon disulfide, miscible carbon disulfide, and the emulsions are inflammable. Fire of all kinds should not be brought into the vicinity.

INGREDIENTS

Miscible carbon disulfide is a mixture of carbon disulfide with castor oil, potassium hydroxide, denatured alcohol, and water. As it can be made satisfactorily only by using high-grade materials, it is necessary to specify carefully the quality of each ingredient.

Carbon disulfide. Use a good grade of technical carbon disulfide which contains only small proportions of free sulfur, hydrogen sulfide, sulfuric acid, or sulfurous acid.

Castor oil. Use a blown castor oil with a specific gravity between 0.991 and 1.004 at 15.5° C. This oil should have an iodine number between 60 and 53, a saponification number between 205 and 216, and a titer of 3. The fatty acids of this oil should have an iodine number between 63 and 53 and an acid value between 210 and 225. An unblown castor oil cannot be used with satisfactory results.

Alcohol. Use 190-proof ethyl alcohol. Ethyl alcohol which has been completely denatured according to formula No. 1 of the United States Bureau of Internal Revenue has been found satisfactory and is recommended. This alcohol contains 10 parts by volume of methanol and 0.5 part of benzene to 100 parts of ethyl alcohol. No permit from the United States Bureau of Internal Revenue is required to handle this grade of denatured alcohol.

Potassium hydroxide. Use a high-grade potassium hydroxide, It should be at least 80 per cent pure and contain not more than 4 per cent potassium carbonate. It should be soluble in alcohol, and should have only traces of sulfates, chlorides, nitrates, or silicates.

Water. Use distilled water, rain water, or water containing not more than traces of dissolved salts. Calcium and magnesium salts are particularly objectionable.

APPARATUS

The castor oil must be saponified by alcoholic potassium hydroxide in a closed kettle which is equipped with a heating device and a mechanical agitator. In the laboratory small quantities of oil have been saponified in a three-necked flask heated over a water bath. The flask was equipped with a mechanical agitator, a thermometer, and a reflux condenser to prevent loss of alcohol.

PREPARATION

Dissolve sufficient potassium hydroxide in a solution composed of 7 parts by volume of alcohol and 3 parts of water to give a concentration of 24.5 to 25.0 per cent potassium hydroxide. (In the laboratory an excess of alkali was dissolved in the alcohol and water, aliquot samples were taken and were standardized against a normal hydrochloric acid solution, and sufficient alcohol and water were added to obtain the proper concentration of potassium hydroxide.) Then mix 55 parts by volume of castor oil with each 10 parts of alcoholic potassium hydroxide. Close the container, start the agitator, and gradually increase the temperature to 200° F. (93.3° C.). Hold at this temperature and agitate until the alkali has reacted completely with the oil. In small batches, 2 hours at 200° F. were sufficient. Test saponification by withdrawing small samples at intervals, mixing them with half their volume of carbon disulfide, and observing their action in water. When the drop breaks into its component parts in water so that carbon disulfide

settles to the bottom in droplets, saponification is not complete; when it breaks into a milky-white liquid which gradually diffuses throughout the water, the proper stage has been reached. The alcoholic soap, when completed, should have the following composition by weight:

	Per cent	Per cent
Total solids:		86.9
Castor oil	83.2	
Potassium hydroxide	3.7	
Total volatile constituents:		13.1
Alcohol	8.6	
Water	4.5	

When the alcoholic castor-oil soap has been prepared, cool it to room temperature and mix with carbon disulfide, using 50 parts by volume of carbon disulfide for each 50 parts of the soap, and stirring the mixture until it is homogeneous. Miscible carbon disulfide can be used immediately, or placed in storage in tight containers. When completed, it should have the following composition by weight:

	Per cent	Per cent
Total solids:		40.40
Castor oil	38.68	
Potassium hydroxide	1.72	
Total volatile constituents:		59.60
Carbon disulfide	53.51	
Alcohol	4.00	
Water	2.09	

The proportion of no ingredient should vary more than 1 per cent from the figure given in the formula.

DOSAGE

The dilution depends upon the minimum temperature of the soil at a depth of six inches, as may be determined from the following table:

40° - 50° F. ---	68 cc.	to 10 gallons of water.
50° - 60° F. ---	57 cc.	" " " " "
60° - 70° F. ---	45 cc.	" " " " "

The concentration of the emulsion should not be greater than is necessary as the increased concentration may injure the plants. Pour the required quantity of miscible carbon disulfide into the water and mix with a stick. Pour the diluted emulsion thus made into a basin about the base of the plant, using 2.5 gallons to a square foot. The soil should not be disturbed for 48 hours after treatment.

SEASON FOR TREATMENT

Dilute carbon disulfide is least injurious to roots when plants are dormant or semi-dormant, and treatment should be applied at that time.